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(54) **METHOD AND APPARATUS FOR ANTENNA PARAMETER NOTIFICATION**

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G01R 29/10 (2006.01)
H04B 1/38 (2015.01)
H01Q 1/24 (2006.01)
H04B 1/40 (2015.01)

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CPC ***G01R 29/10*** (2013.01); *H01Q 1/24* (2013.01); *H04B 1/38* (2013.01); *H04B 1/40* (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/24; H04B 1/38; H04B 1/40; G01R 29/10
USPC 342/360
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,903,237	A	5/1999	Crosby et al.	
6,385,466	B1 *	5/2002	Hirai et al.	455/566
7,065,324	B2 *	6/2006	Mee et al.	455/67.11
7,292,178	B1 *	11/2007	Woodell et al.	342/26 B
7,733,968	B2	6/2010	Ling et al.	
8,259,020	B1 *	9/2012	Macy et al.	343/766
2003/0162558	A1 *	8/2003	Takase et al.	455/550
2003/0223947	A1 *	12/2003	Alvarez	424/70.12
2004/0121742	A1	6/2004	Abrams et al.	
2008/0132283	A1	6/2008	Ponce De Leon et al.	
2008/0309254	A1 *	12/2008	Berger	315/297
2009/0009527	A1 *	1/2009	Kuga et al.	345/589
2009/0066666	A1	3/2009	Sagou	
2011/0159920	A1	6/2011	Lehmann	
2012/0270606	A1 *	10/2012	Kim et al.	455/566
2013/0265202	A1	10/2013	Soora	
2014/0128032	A1	5/2014	Muthukumar	

FOREIGN PATENT DOCUMENTS

EP	2157770	A1	2/2010
WO	2009/101618	A1	8/2009

OTHER PUBLICATIONS

Related European Patent Application No. EP 12174987.3 Search Report dated Dec. 20, 2012.
Corresponding European Patent Application No. EP 12174989.9 Search Report dated Dec. 20, 2012.
Notice of Allowance dated Apr. 17, 2015, issued on Related U.S. Appl. No. 13/541,701, 13 pages.

* cited by examiner

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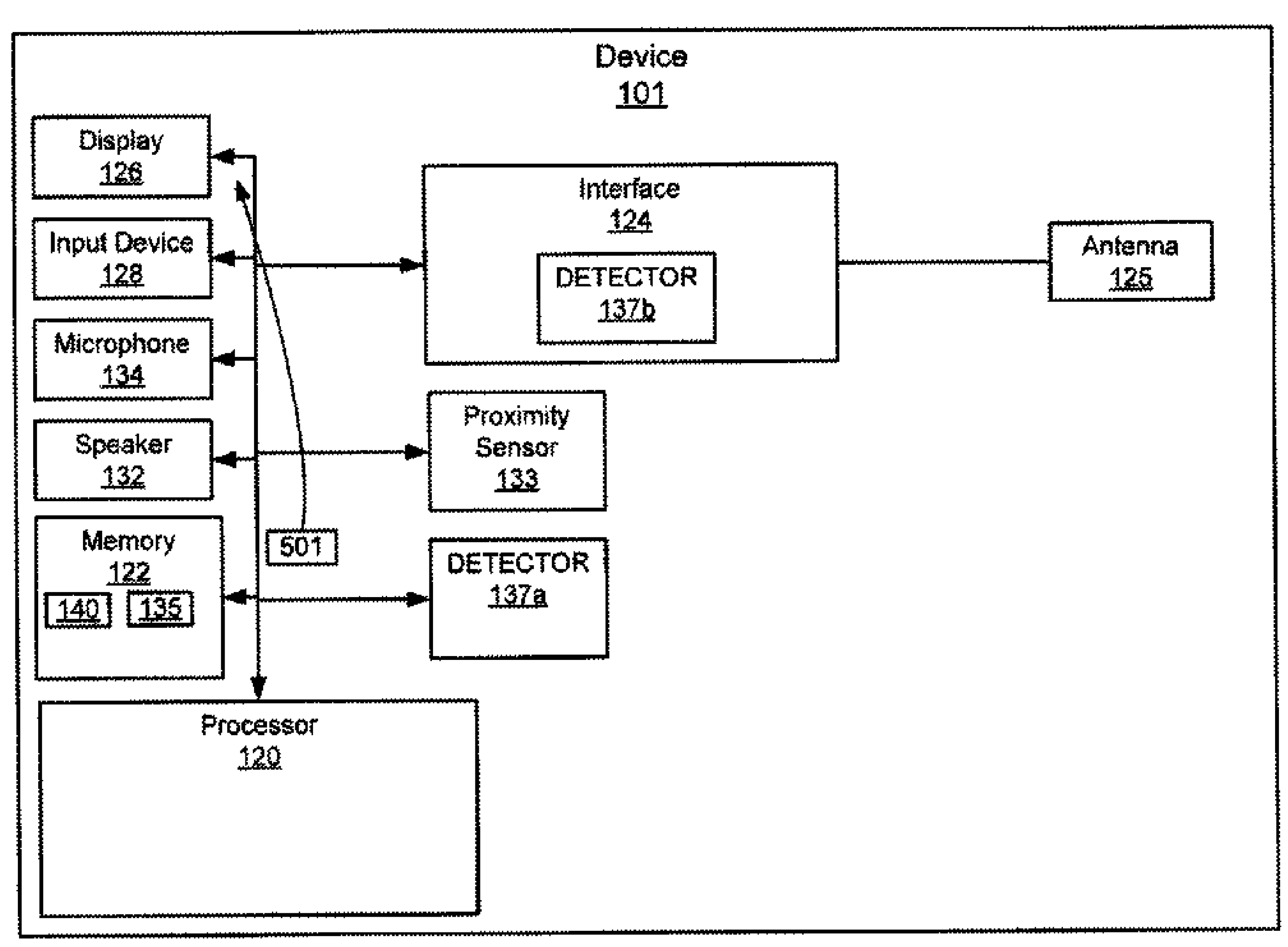
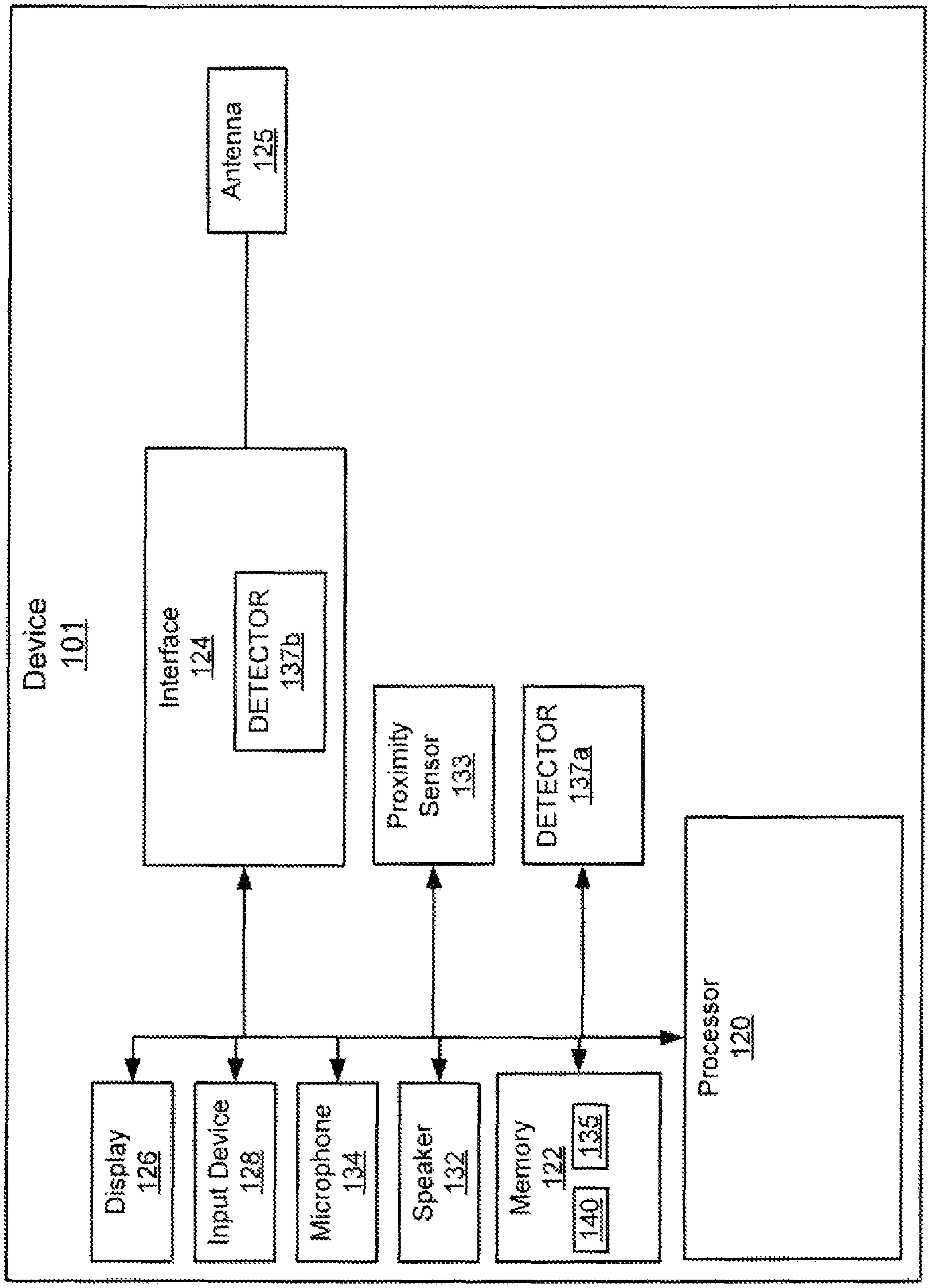
(57) **ABSTRACT**

A method and apparatus for antenna parameter notification is provided. At a device comprising at least one processor, an antenna, and a display, a parameter associated with performance of the antenna is determined at the processor. When the parameter meets a given criteria then the processor changes a brightness of the display.

13 Claims, 6 Drawing Sheets





Device
101
Antenna
125
Interface
124
DETECTOR
137b
Proximity
Sensor
133
DETECTOR
137a
Processor
120
Display
126
Input Device
128
Microphone
134
Speaker
132
Memory
122
135
140

Fig. 1

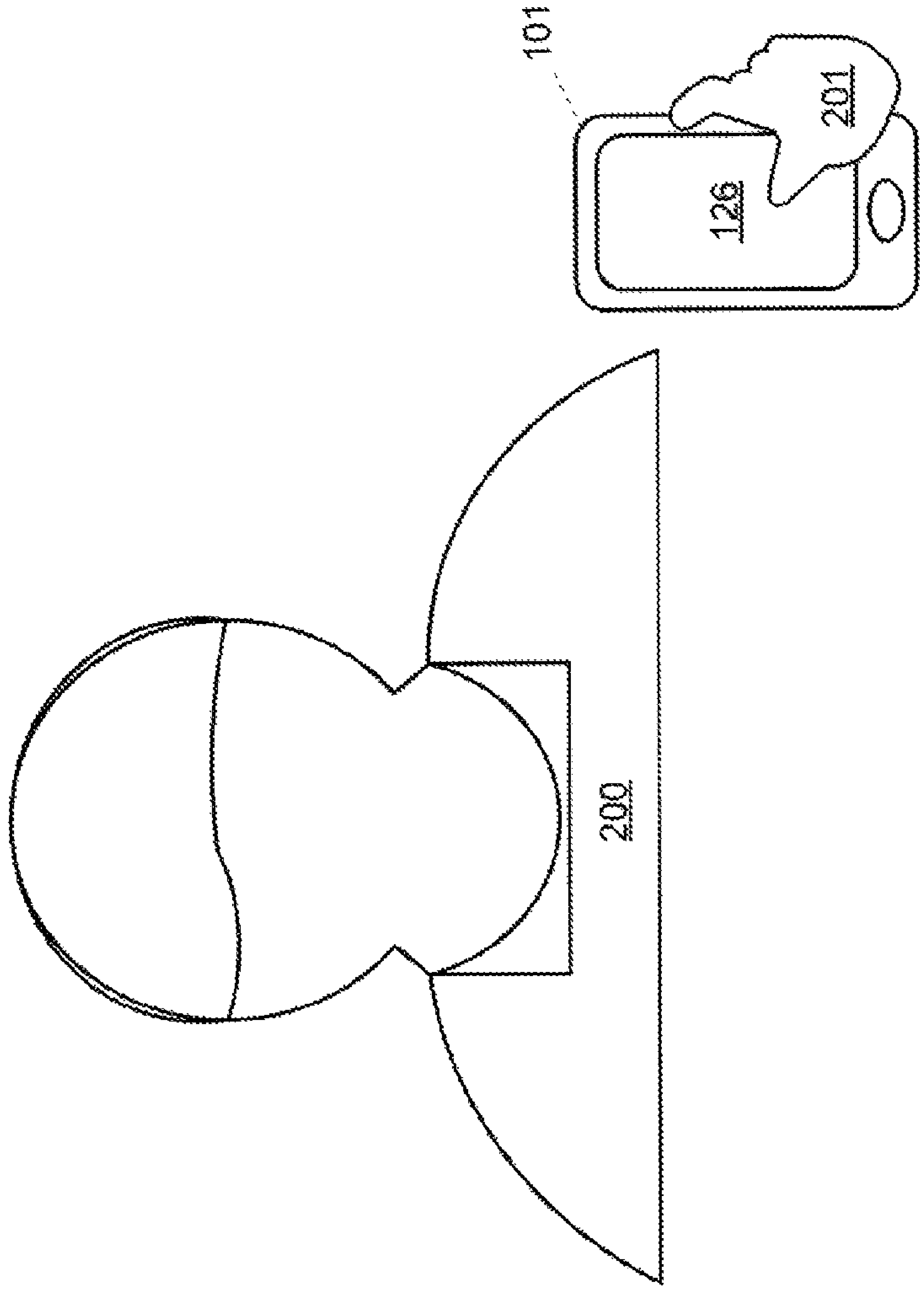


Fig. 2

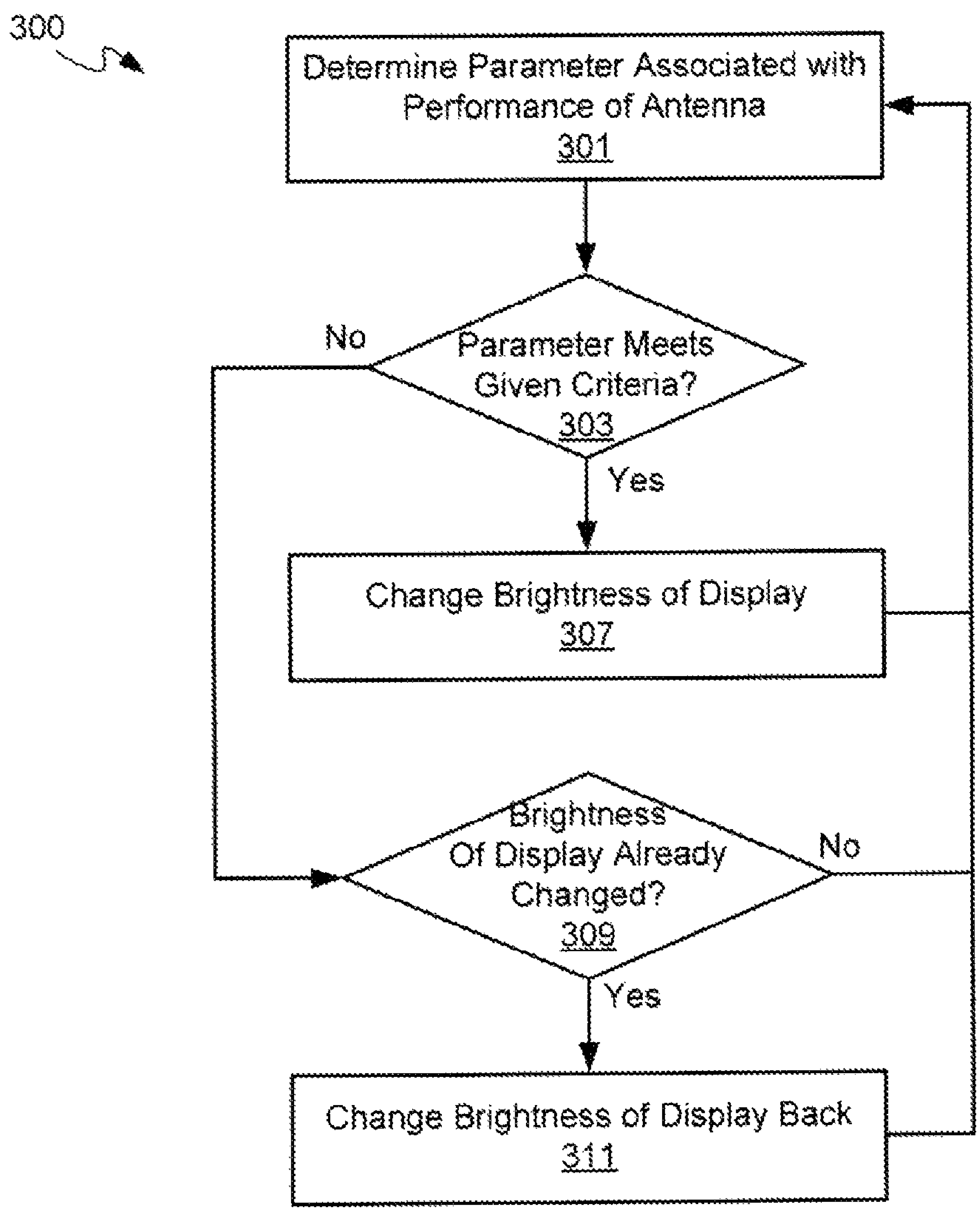

300
Determine Parameter Associated with Performance of Antenna
301
Parameter Meets Given Criteria?
303
No
Yes
Change Brightness of Display
307
Brightness Of Display Already Changed?
309
No
Yes
Change Brightness of Display Back
311

Fig. 3

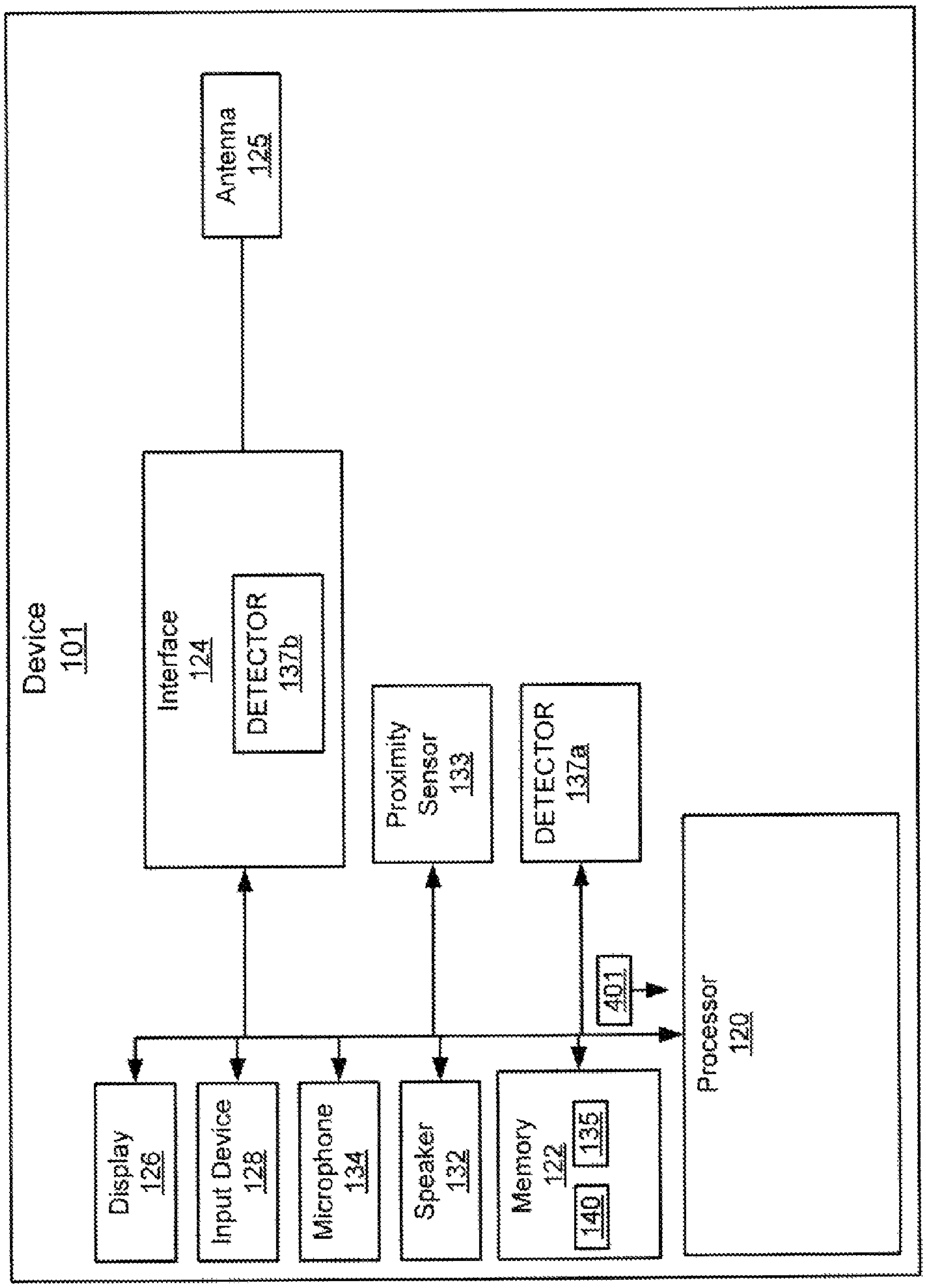

Device
101
Antenna
125
Interface
124
DETECTOR
137b
Proximity
Sensor
133
DETECTOR
137a
401
Processor
120
Display
126
Input Device
128
Microphone
134
Speaker
132
Memory
122
140
135

Fig. 4

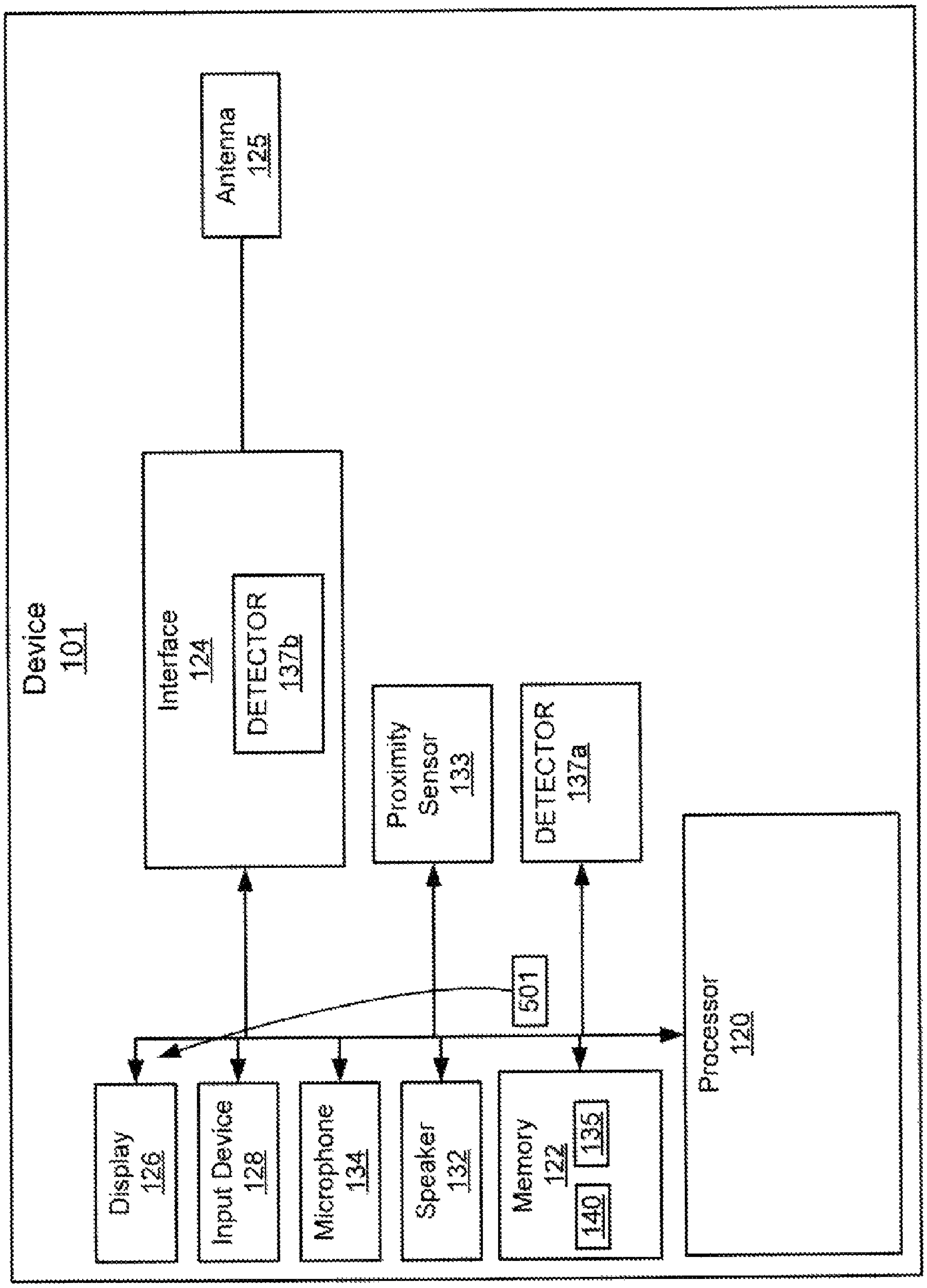

Device
101
Antenna
125
Interface
124
DETECTOR
137b
Proximity
Sensor
133
DETECTOR
137a
501
Processor
120
Display
126
Input Device
128
Microphone
134
Speaker
132
Memory
122
140
135

Fig. 5

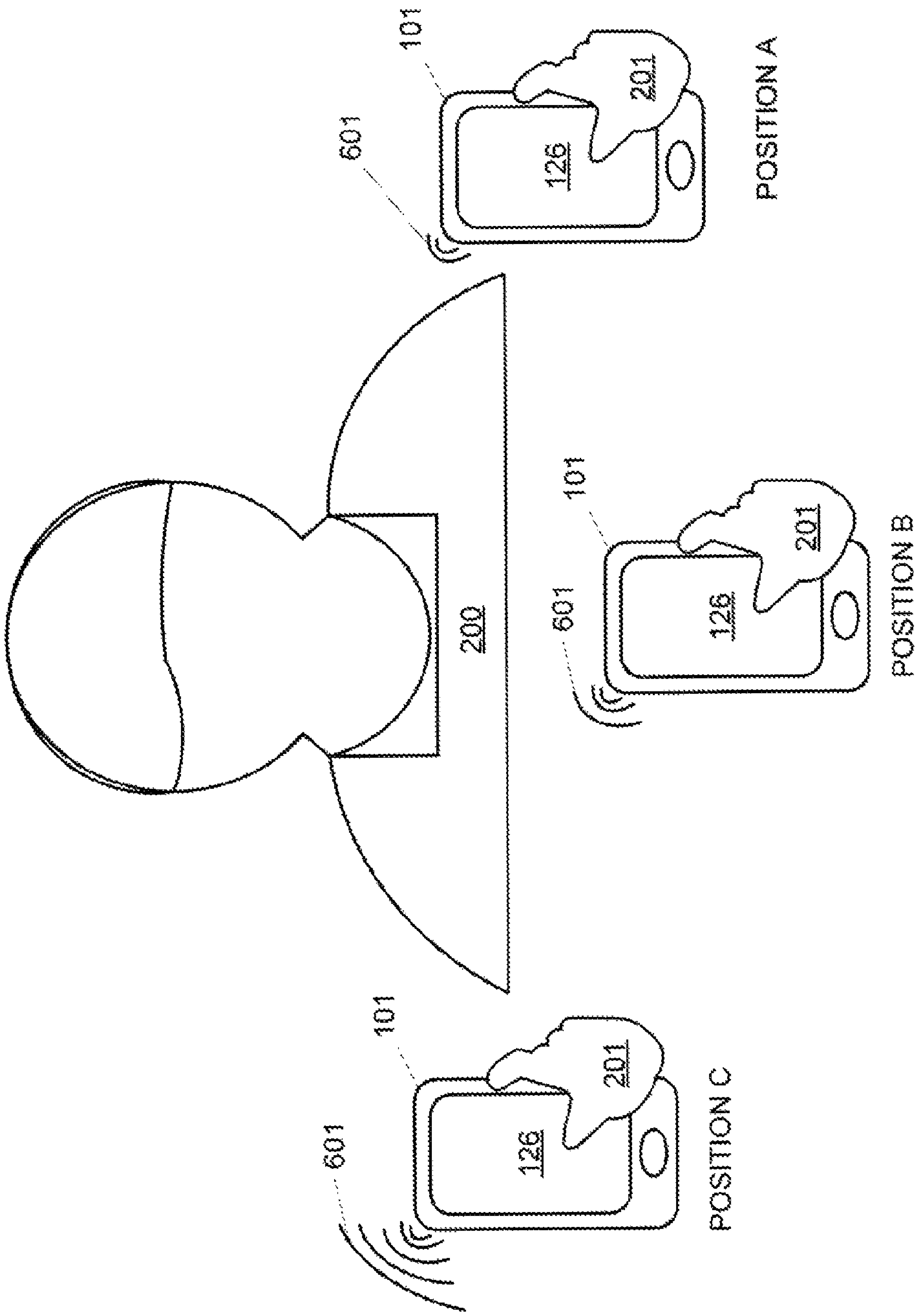

101
601
126
201
POSITION A
200
101
601
126
201
POSITION B
101
601
126
201
POSITION C

Fig. 6

METHOD AND APPARATUS FOR ANTENNA PARAMETER NOTIFICATION

FIELD

The specification relates generally to antennas, and specifically to a method and apparatus for antenna parameter notification.

BACKGROUND

Mobile devices are generally trending towards being slimmer (and even flexible), with MIMO (multiple-in-multiple-out) antennas. In such mobile devices, tuneable antennas and adaptive impedance matching techniques are important. However, for some cases, such dynamic techniques do not provide optimized radio performance. For example, device orientation, device shape, slider and/or flip position, hand position, interference between multiple radios, SAR (specific absorption rate) requirements and the like, all affect antenna performance due to resulting changes in coupling, out of tuning range, and the like.

BRIEF DESCRIPTIONS OF THE DRAWINGS

For a better understanding of the various implementations described herein and to show more clearly how they may be carried into effect, reference will now be made, by way of example only, to the accompanying drawings in which:

FIG. **1** depicts a schematic diagram of device for antenna parameter notification, according to non-limiting implementations.

FIG. **2** depicts a perspective view of the device of FIG. **1** in use, according to non-limiting implementations.

FIG. **3** depicts a flowchart of a method for antenna parameter notification, according to non-limiting implementations.

FIG. **4** depicts the device of FIG. **1** showing a determination of a parameter associated with antenna performance, according to non-limiting implementations.

FIG. **5** depicts the device of FIG. **1** showing a processor changing a display brightness in response to the parameter meeting a given criteria and a determination of a proximity, according to non-limiting implementations.

FIG. **6** depicts a perspective view of the device of FIG. **1** with the brightness of a display being increased, according to non-limiting implementations.

DETAILED DESCRIPTION

A first aspect of the specification provides a device comprising: at least one processor, an antenna, and a display, the at least one processor enabled to: determine a parameter associated with performance of the antenna; and, when the parameter meets a given criteria then change a brightness of the display.

The parameter can comprise one or more of a SAR parameter, an impedance parameter, a voice quality parameter, a VSWR parameter, a FER parameter, an EVM parameter, a BER parameter, a bandwidth parameter, and a QoS parameter, and the given criteria respectively comprises one or more of a threshold SAR level, one or more of a threshold impedance level and a given range of acceptable impedance levels, one or more voice quality threshold levels, one or more VSWR thresholds, one or more FER thresholds, one or more EVM thresholds, one or more BER thresholds, one or more bandwidth thresholds, and one or more QoS thresholds.

The parameter can comprise a reception of the antenna, and the given criteria can comprise the reception being out of a given range thereby indicating poor reception at the antenna.

The parameter can comprise an impedance of the antenna, and the given criteria can comprise the impedance being out of a given range thereby indicating impedance mismatch between the antenna and associated radio equipment.

The parameter can comprise voice quality provided at the speaker, and the given criteria can comprise the voice quality being below a given voice quality threshold level.

The processor can be further enabled to change the brightness of the display as a function of the parameter, such that change in the brightness of the display varies according to the parameter.

The processor can be further enabled to monitor the parameter and change the brightness of the display in a feedback loop with the parameter.

The processor can be further enabled to change the brightness of the display in a pattern.

At least a portion of the device can be flexible and the processor can be further enabled to change the brightness of the display as a shape of the device changes.

Another aspect of the specification provides a method comprising: at a device comprising at least one processor, an antenna, and a display, determining, at the processor, a parameter associated with performance of the antenna; and, when the parameter meets a given criteria then changing a brightness of the display.

The parameter can comprise one or more of a SAR parameter, an impedance parameter, a voice quality parameter, a VSWR parameter, a FER parameter, an EVM parameter, a BER parameter, a bandwidth parameter, and a QoS parameter, and the given criteria respectively can comprise one or more of a threshold SAR level, one or more of a threshold impedance level and a given range of acceptable impedance levels, one or more voice quality threshold levels, one or more VSWR thresholds, one or more FER thresholds, one or more EVM thresholds, one or more BER thresholds, one or more bandwidth thresholds, and one or more QoS thresholds.

The parameter can comprise a reception of the antenna, and the given criteria can comprise the reception being out of a given range thereby indicating poor reception at the antenna.

The parameter can comprise an impedance of the antenna, and the given criteria can comprise the impedance being out of a given range thereby indicating impedance mismatch between the antenna and associated radio equipment.

The parameter can comprise voice quality provided at the speaker, and the given criteria can comprise the voice quality being below a given voice quality threshold level.

The method can further comprise changing the brightness of the display as a function of the parameter, such that change in the brightness of the display varies according to the parameter.

The method can further comprise monitoring the parameter and changing the brightness of the display in a feedback loop with the parameter.

The method can further comprise changing the brightness of the display in a pattern.

At least a portion of the device can be flexible and the method further can comprise changing the brightness of the display as a shape of the device changes.

Yet another aspect of the specification provides a computer program product, comprising a computer usable medium having a computer readable program code adapted to be executed to implement a method comprising: at a device comprising at least one processor, an antenna, and a display, determining, at the processor, a parameter associated with performance of the antenna; and, when the parameter meets a given criteria then changing a brightness of the display. The computer program product can be non-transitory.

FIG. **1** depicts a schematic diagram of a device **101** for antenna parameter notification, according to non-limiting implementations. Device **101** comprises a processor **120** interconnected with a memory **122**, a communications interface **124**, an antenna **125**, a display **126**, an input device **128**, a speaker **132**, at least one optional proximity sensor **133**, and a microphone **134**. Communications interface **124** will be interchangeably referred to as interface **124**. As will be presently explained, processor **120** is generally enabled for antenna parameter notification; specifically, processor **120** is enabled to: determine a parameter associated with performance of antenna **125**; and, when the parameter meets a given criteria **135**, stored at memory **122**, then change a brightness of display **126**.

It is appreciated that brightness can include any suitable indication of brightness, including, but not limited to, luminance, luminous intensity, and the like. It is yet further appreciated that changing a brightness of display **16** can comprise controlling an electrical property of display **126**, including but not limited to one or more of a voltage and a current.

Device **101** can be any type of electronic device that can be used in a self-contained manner to communicate with one or more communication networks using antenna **125**. Device **101** includes, but is not limited to, any suitable combination of electronic devices, communications devices, computing devices, personal computers, laptop computers, portable electronic devices, mobile computing devices, portable computing devices, tablet computing devices, laptop computing devices, desktop phones, telephones, PDAs (personal digital assistants), cellphones, smartphones, e-readers, internet-enabled appliances and the like. Other suitable devices are within the scope of present implementations.

However, it is appreciated that, regardless of the configuration of device **101**, device **101** is generally enabled to control a brightness of display **126**, for example as depicted in FIG. **2**, which depicts a perspective view of device **101** in use. Specifically, in FIG. **2**, a user **200** is holding device **101** in his/her hand **201**, for example in a position so that user **200** can see display **126**. Display **126** can be controlled when user **200** is holding device **101**. In some implementations, device **101** can be in use in FIG. **2** during a telephone call conducted using a speakerphone mode at device **101** such that a telephone call can be conducted while user **200** can view display **126**.

Attention is now directed back to FIG. **1**: it should be emphasized that the structure of device **101** in FIG. **1** is purely an example, and contemplates a device that can be used for both wireless voice (e.g. telephony) and wireless data communications (e.g. email, web browsing, text, and the like). However, while FIG. **1** contemplates a device that can be used for telephony, in other implementations, device **101** can comprise a device enabled for implementing any other suitable specialized functions, including, but not limited, to one or more of, computing, appliance, and/or entertainment related functions.

Device **101** comprises at least one input device **128** generally enabled to receive input data, and can comprise any suitable combination of input devices, including but not limited to a keyboard, a keypad, a pointing device, a mouse, a track wheel, a trackball, a touchpad, a touch screen and the like. Other suitable input devices are within the scope of present implementations.

Input from input device **128** is received at processor **120** (which can be implemented as a plurality of processors, including but not limited to one or more central processors (CPUs)). Processor **120** is configured to communicate with a memory **122** comprising a non-volatile storage unit (e.g. Erasable Electronic Programmable Read Only Memory ("EEPROM"), Flash Memory) and a volatile storage unit (e.g. random access memory ("RAM")). Programming instructions that implement the functional teachings of device **101** as described herein are typically maintained, persistently, in memory **122** and used by processor **120** which makes appropriate utilization of volatile storage during the execution of such programming instructions. Those skilled in the art will now recognize that memory **122** is an example of computer readable media that can store programming instructions executable on processor **120**. Furthermore, memory **122** is also an example of a memory unit and/or memory module.

In particular, it is appreciated that memory **122** stores an application **140** that, when processed by processor **120**, enables processor **120** to: determine a parameter associated with performance of antenna **125**; and, when the parameter meets a given criteria **135**, stored at memory **122**, then change a brightness of display **126**.

The brightness of display **126** can be increased or decreased. In some implementations, the brightness of display **126** is changed to a given brightness level stored at memory **122**

Processor **120** can be further configured to communicate with display **126**, and microphone **134** and speaker **132**. Display **126** comprises any suitable one of, or combination of, CRT (cathode ray tube) and/or flat panel displays (e.g. LCD (liquid crystal display), plasma, OLED (organic light emitting diode), capacitive or resistive touchscreens, and the like). In implementations where display **126** comprises an LCD display, display **126** further comprises a backlight (not depicted), which is controlled by processor **120** to, in turn, control brightness of display **126**.

Microphone **134**, comprises any suitable microphone for receiving sound data.

Speaker **132** comprises any suitable speaker for providing sound data, audible alerts, audible communications from remote communication devices, and the like, at device **101**.

In some implementations, input device **128** and display **126** are external to device **101**, with processor **120** in communication with each of input device **128** and display **126** via a suitable connection and/or link.

Processor **120** also connects to interface **124**, which can be implemented as one or more radios and/or connectors and/or network adaptors, configured to wirelessly communicate with one or more communication networks (not depicted) via antenna **125**. It will be appreciated that interface **124** is configured to correspond with network architecture that is used to implement one or more communication links to the one or more communication networks, including but not limited to any suitable combination of USB (universal serial bus) cables, serial cables, wireless links, cell-phone links, cellular network links (including but not limited to 2G, 2.5G, 3G, 4G+, UMTS (Universal Mobile Telecommunications System), CDMA (Code division multiple access), WCDMA (Wideband CDMA), FDD (frequency division duplexing), TDD (time division duplexing), TDD-LTE (TDD-Long Term Evolution), TD-SCDMA (Time Division Synchronous Code Division Multiple Access) and the like, wireless data, Bluetooth links, NFC (near field communication) links, WiFi links, WiMax links, packet based links, the Internet, analog networks, the PSTN (public switched telephone network), access points, and the like, and/or a combination.

Specifically, interface **124** comprises radio equipment (i.e. a radio transmitter and/or radio receiver) for receiving and transmitting signals using antenna **125**. It is further appreciated that interface **124** can comprise a variable tuning circuit for tuning antenna **125**, for example by matching impedance of antenna **125** to the radio equipment. The variable tuning circuit can hence comprise any suitable combination of capacitors and impedance coils (also referred to as inductors) for matching impedance of antenna **125** to the radio equipment of interface **124**.

It is appreciated that processor **120** is generally enabled to determine a parameter associated with performance of antenna **125**. The parameter can comprise one of or more of a reception parameter, a SAR parameter, an impedance parameter, a voice quality parameter, a VSWR (voltage standing wave ratio) parameter, a FER (frame error rate) parameter, an EVM (error vector magnitude) parameter, a BER (bit error rate) parameter, a bandwidth parameter, and a QoS (Quality of Service) parameter.

As such, device **101** can further comprise one or more detectors **137***a*, **137***b* (also referred to hereafter, generically, as a detector **137** and collectively as detectors **137**) for measuring the parameter, including, but not limited to, one or more of a reception detector, a SAR detector, an impedance detector, a voice quality detector, a VSWR detector, an FER detector, an EVM detector, a BER detector, a bandwidth detector, and a QoS detector. It is further appreciated that detectors **137** can be implemented as a combination of hardware and software. For example, when one or more of detectors **137** comprise a BER detector, processor **120** can comprise one or more of detectors **137** implemented as software.

When implemented as hardware, one or more of detectors **137** can be a distinct component of device **101** and/or one or more of detectors **137** can be an element of interface **124**.

For example, in some implementations, detector **137***a*, at interface **124**, can comprise a detector for detecting reception of antenna **125**. Hence, in yet further implementations, interface **124** can comprise a processor associated with one or more of radio equipment, a variable tuning circuit and detector **137***b*.

In other implementations, detector **137***a* can comprise a SAR detector for detecting SAR at device **101**. In other implementations, detector **137***b*, at interface **124**, can comprise one or more of a reception detector and a SAR detector, as interface **124** is in communication with antenna **125** and can determine a level of radiation being received and/or transmitted by antenna **125**.

In other implementations, detector **137***a* can comprise a detector for detecting voice quality at speaker **132**; for example when antenna performance is low (i.e. when impedance matching is poor and/or radio signal quality is low) voice quality in a telephone call can be affected; for example, the volume can be reduced, noise can increase, and the like. Detector **137***a*, implemented as software, hardware and/or a combination thereof, can be enabled to determine voice quality. In some of these implementations, detector **137***a* comprises a digital signal processor (DSP) for determining voice quality.

It is yet further appreciated that interface **124** can comprise detector **137***b* which in turn comprises a measurement circuit for measuring reception and/or SAR at antenna **125**.

In other implementations, interface **124** can comprise detector **137***b* which in turn comprises a measurement circuit for measuring impedance of antenna **125**, including but not limited to impedance mismatches between antenna **125** and radio equipment at interface **124**. Detector **137***b*, when present, can comprise any suitable circuit for measuring reception and/or impedance of antenna **125**, and can hence comprise any suitable combination of signal transmitter, signal receiver, capacitors and impedance coils for measuring reception and/or impedance of antenna **125**. It is yet further appreciated that detector **137***b* can alternatively be enabled to determine radiation levels associated with antenna **125**, and hence SAR can be determined.

In specific non-limiting implementations, device **101** can comprise a phone device, and antenna **125** comprises a main antenna, for example for communicating with a cell phone network.

Optional proximity sensor **133**, when present, can comprise any suitable proximity sensor, including, but not limited to, IR (infrared) diode/detectors, capacitive sensors, capacitive displacement sensors, Doppler effect sensors, eddy-current sensor, inductive sensors, laser sensors, optical sensors, acoustic sensors, magnetic sensors, passive optical sensors (such as charge-coupled devices), passive thermal infrared sensors, photocell sensors (reflective), magnetometers, gyroscopes, accelerometers, altimeters and the like.

Further, proximity sensor **133**, when present, can be located at any position on device **101** for detecting one or more of a head of a user and a hand of a user. For example, proximity sensor **133** can be adjacent speaker **132** such that proximity sensor **133** detects proximity when a head of a user is adjacent speaker **132**, as in FIG. **2**. Alternatively, proximity sensor **133** can be positioned at device **101** to detect a hand of a user when user is holding device **101**. In yet further implementations, proximity sensor **133** can comprise one or more proximity sensors for determining proximity when device **101** is being held by a hand of a user. In other words, in some implementations, regardless of the location and/or number of proximity sensor **133**, proximity sensor **133** is enabled to sense one or more of a head-hand mode of device **101** and a hand-held mode of device **101**.

It is further appreciated that such a head-hand mode and/or hand-held mode can be indicated by virtue of determining proximity at proximity detector **133**, and that processor **120** need not make a specific determination of a head-hand mode and/or a hand-held mode.

It is yet further appreciated that device **101** comprises a power source, not depicted, for example a battery or the like. In some implementations the power source can comprise a connection to a mains power supply and a power adaptor (e.g. and AC-to-DC (alternating current to direct current) adaptor).

In any event, it should be understood that a wide variety of configurations for device **101** are contemplated.

Hence attention is now directed to FIG. **3** which depicts a flowchart of a method **300** for antenna parameter notification, according to non-limiting implementations. In order to assist in the explanation of method **300**, it will be assumed that method **300** is performed using device **101** to use display **126** for antenna parameter notification. Furthermore, the following discussion of method **300** will lead to a further understanding of device **101** and its various components. However, it is to be understood that device **101** and/or method **300** can be varied, and need not work exactly as discussed herein in conjunction with each other, and that such variations are within the scope of present implementations.

It is appreciated that, in some implementations, method **300** is implemented in device **101** by processor **120** processing application **140**. Indeed, method **300** is one way in which device **101** can be configured. It is to be emphasized, however, that method **300** need not be performed in the exact sequence as shown, unless otherwise indicated; and likewise various blocks may be performed in parallel rather than in sequence; hence the elements of method **300** are referred to herein as "blocks" rather than "steps". It is also to be understood, however, that method **300** can be implemented on variations of device **101** as well. For example, in implementations where interface **124** comprises a processor and method **300** can be implemented at interface **124**.

Further, the following discussion of method **300** will be done with reference to FIGS. **4** and **5**, each of which are similar to FIG. **1**, with like elements having like numbers.

At block **301**, processor **120** determines a parameter associated with performance of antenna **125**. For example, processor **120** can communicate with one or more of detectors **137** and interface **124** to receive data **401** indicative of performance of antenna **125**. The parameter can comprise one of or more of a reception parameter, a SAR parameter, an impedance parameter, a voice quality parameter, a VSWR parameter, a FER parameter, an EVM parameter, a BER parameter, a bandwidth parameter, and a QoS parameter.

For example, in some implementations, the determined parameter can comprise a reception of antenna **125**, for example as antenna **125** interacts with a communication network, and hence data **401** is indicative of a reception level. In other implementations, the determined parameter can comprise a SAR level, and hence data **401** is indicative of SAR level. In other implementations, the parameter comprises an impedance of antenna **125**, and hence data **401** is indicative of impedance of antenna **125**, which in turn can be indicative of an impedance mismatch between antenna **125** and radio equipment at interface **124**. In yet further implementations, the parameter comprises an indication of voice quality provided at speaker **132**, and hence data **401** is indicative of voice quality at speaker **132**. However, it is further appreciated that, in some implementations, the parameter can be determined by processor **120** without receipt of data **401**. In other words, in implementations where processor **120** comprises detector **137***a*, processor **120** can determine the parameter associated with performance of antenna **125** without receipt of data **401**.

It is further appreciated that in some implementations, at block **301**, more than one parameter can be determined, for example more than one of the parameters described above.

At block **303**, processor **120** compares the parameter to given criteria **135**. When more than one parameter is determined, each parameter can be compared to respective given criteria **135**. Either way, it is appreciated that given criteria **135** is commensurate with the parameter. Hence, when parameter comprises one or more of a reception parameter, a SAR parameter, an impedance parameter, a voice quality parameter, a VSWR parameter, a FER parameter, an EVM parameter, a BER parameter, a bandwidth parameter, and a QoS parameter, given criteria **135** respectively comprises one or more of a threshold reception level, threshold SAR level, one or more threshold impedance levels and for a given range of acceptable impedance levels, one or more voice quality threshold levels, one or more VSWR thresholds, one or more FER thresholds, one or more EVM thresholds, one or more BER thresholds, one or more bandwidth thresholds, and one or more QoS thresholds.

For example, when the parameter comprises a reception of antenna **125**, given criteria **135** comprises the reception being out of a given range thereby indicating poor reception at antenna **125**. Similarly, when the parameter comprises a SAR level, given criteria **135** can comprise the SAR level exceeding a threshold SAR level, including but not limited to a predetermined threshold SAR level that is considered inappropriate exposure for human beings. When the parameter comprises an impedance of antenna **125**, or the like, given criteria **135** can comprise the impedance being out of a given range of impedance, thereby indicating impedance mismatch between antenna **125** and associated radio equipment at interface **124**. When the parameter comprises voice quality provided at speaker **132**, given criteria **135** can comprise the voice quality being below a given voice quality threshold level.

In any event, at block **303**, when the parameter does not meet given criteria **135** (i.e. a "No" decision at block **303**), blocks **301** and **303** are repeated, presuming that brightness of display **126** has not already been changed (i.e. block **307**, described below, has not previously occurred) such that processor **120** is generally enabled to monitor one or more parameters associated with performance of antenna **125**. In implementations where more than one parameter is compared to respective criteria **135**, memory **122** can store rules for determining priority of the parameters such that when some of parameters do not meet respective given criteria **135**, while other parameters do meet respective given criteria **135**, a "No" decision is reached at block **303**. For example, a SAR level parameter exceeding a threshold SAR level can be given priority over reception of antenna **125** being acceptable.

However, at block **303**, when the parameter does meet given criteria **135** (i.e. a "Yes" decision at block **303**), at block **307**, processor **120** changes brightness at display **126**. For example, attention is directed to FIG. **5** where processor **120** controls display **126** **132** to change the brightness via a command and/or signal **501**.

Such a change in brightness of display **126** is indicative that a parameter associated with performance of antenna **125** has met given criteria **135**, and further indicative that the performance of antenna **125** is poor. As a result, the change in brightness of display **126** can serve as a prompt to a user to adjust device **101** to improve performance of antenna **125**, for example by adjusting a position of device **101**.

Returning to FIG. **3**, the brightness of display **126** can be increased or decreased at block **307**. In some implementations, the brightness of display **126** is changed to a given brightness level that can be stored at memory **122**. It is appreciated that the change in brightness is generally enabled to be noticeable to a human being, as can be determined by a person of skill in the art.

Further at block **307**, when processor **120** changes brightness of display **126** (for example to the given brightness), the brightness change can be sudden, for example as a step-function, or the brightness change can be gradual, for example a linear or exponential change over a given time period, such as about 5 seconds or the like.

In yet further implementations, at block **307**, processor **120** changes brightness of display **126** as a function of one or more of the parameters, for example according to a function B=F(P), where B is the brightness of display **126** expressed in any suitable units, including but not limited to luminance units, F is a suitable function and P is one or more of the parameters. Hence, brightness of display **126** varies according to the one or more parameters, e.g. the parameter, P. In some implementations, the function F can comprise a linear function, while, in other implementations, the function F can comprise an exponential function.

In yet further implementations, the function F can be non-linear, for example a function of two or more of the parameters, such as B=F(P1, P2, P3 . . . Pn), where each of P1, P2, P3 . . . Pn is a different one of the parameters: further while four parameters are shown function F can be dependent on any number of the parameters.

It is further appreciated that, in some implementations, brightness B of function B=F(P) can be expressed in terms of an electrical parameter of display **126**. For example, brightness can be related to one or more a current and a voltage supplied to display **126**, and hence brightness B can be correspondingly expressed as a current and a voltage supplied to display **126**.

In any event, once brightness of display **126** is changed at block **307**, blocks **301** to **303** occur again. When block **307** is reached again (i.e. the parameter continues to meet given criteria **135**), the brightness of display **126** can again be changed. Alternatively, when the brightness of display **126** has already been changed, no further changes occur.

However, when a "No" decision is reached at block **303**, at block **309** processor **120** determines whether block **307** has been previously implemented, i.e. to determine whether brightness of display **126** has already been changed. If so (i.e. a "Yes" decision at block **309**, and processor **120** has already changed the brightness of display **126** at block **307**), at block **311**, the brightness of display **126** is changed back to a brightness level similar to the brightness of display **126** before block **307** occurred. Blocks **301** to **303** then reoccur until a "Yes" decision again occurs at block **303**. It is further appreciated that the brightness of display **126** can be changed at block **311** according to the function B=F(P) described above.

It is further appreciated that method **300** can be implemented as a feedback loop. In other words, processor **120** can be enabled to monitor the parameter and change (i.e. increase and/or decrease) the brightness of display **126** in a feedback loop with the parameter, such that as the parameter changes, the brightness of display **126** changes, for example according to the function B=F(P) dekribed above. Hence, when a user sees a change in the brightness of display **126**, the user can react by moving device **101** until the user sees the brightness of display **126** change again. The user can hence position device **101** until the brightness of display **126** is stable, and hence the parameter is also stable.

This situation is depicted in FIG. **6**, substantially similar to FIG. **2**, with like elements having like numbers, where user **200** moves device **101** from Position A to Position B to Position C. At Position A, brightness **601** of display **126** is dimmed, for example due to poor reception at antenna **125** or the like, as described above. At Position B, brightness **601** increases as the reception at antenna **125** is better than at Position A. At Position C, brightness **601** increases again as the reception at antenna **125** is better than at Position B. The increase in brightness **601** is depicted in FIG. **6** by an increase in the number of lines representing brightness **601**, but it is appreciated that user **200** will view a luminance of display **126** increasing in intensity.

In yet further implementations, brightness of display **126** can change as a pattern, including but not limited to a periodic pattern. For example, brightness of display **126** can go gradually low, to a bottom limit, then increase to a top limit for a given number of times, until improved antenna parameters and/or improved RF performance occurs.

In some implementations, at least a portion of device **101** is flexible, and the parameter can be affected by the shape of device **101**. In these implementations, the processor **120** can be enabled to change the brightness of display **126** as a shape of device **101** changes, which in turn causes the monitored parameter associated with performance of antenna **125** to change.

In this manner, the brightness of display **126** can be controlled by processor **120** to reflect a poor performance of antenna **125**, which in turn can cause a user to take action to improve the performance of antenna **125** by moving device **101** as depicted in FIG. **6**.

Persons skilled in the art will appreciate that there are yet more alternative implementations and modifications possible. For example, in implementations where device **101** comprises proximity detector **133**, method **300** can include a block for determining proximity of one or more of a hand and a head, such that processor **120** can determine whether device **101** is in hand-held mode or a hand-head mode. In some of these implementations, method **300** occurs only when device **101** is in a hand-held mode. For example, method **300** can occur only when proximity detector **133** detects proximity at a rear and/or side of device **101**. In others of these implementations, method **300** does not occur when device **101** is in a hand-head mode as presumably display **126** is not visible to a viewer in such a mode. For example, method **300**, prior to block **301**, processor **120** determines that proximity detector **133** has determined proximity one or more of adjacent display **126** and adjacent speaker **132**, indicating that display **126** is not viewable by a user, and method **300** does not occur.

Hence, in general, a display of a device can be used as an indicator to find the best reception for an antenna, which generally improves the performance of the device. Further, by using existing components of the device, no component cost is added to the device.

Those skilled in the art will appreciate that in some implementations, the functionality of device **101** can be implemented using pre-programmed hardware or firmware elements (e.g., application specific integrated circuits (ASICs), electrically erasable programmable read-only memories (EEPROMs), etc.), or other related components. In other implementations, the functionality of device **101** can be achieved using a computing apparatus that has access to a code memory (not shown) which stores computer-readable program code for operation of the computing apparatus. The computer-readable program code could be stored on a computer readable storage medium which is fixed, tangible and readable directly by these components, (e.g., removable diskette, CD-ROM, ROM, fixed disk, USB drive). Furthermore, it is appreciated that the computer-readable program can be stored as a computer program product comprising a computer usable medium. Further, a persistent storage device can comprise the computer readable program code. It is yet further appreciated that the computer-readable program code and/or computer usable medium can comprise a non-transitory computer-readable program code and/or non-transitory computer usable medium. Alternatively, the computer-readable program code could be stored remotely but transmittable to these components via a modem or other interface device connected to a network (including, without limitation, the Internet) over a transmission medium. The transmission medium can be either a non-mobile medium (e.g., optical and/or digital and/or analog communications lines) or a mobile medium (e.g., microwave, infrared, free-space optical or other transmission schemes) or a combination thereof.

Persons skilled in the art will appreciate that there are yet more alternative implementations and modifications possible, and that the above examples are only illustrations of one or more implementations. The scope, therefore, is only to be limited by the claims appended hereto.

What is claimed is:

1. A device comprising:

at least one processor interconnected with an antenna, and a display, the display comprising a backlight, the backlight controlled by the at least one processor to control a brightness of the display, the at least one processor configured to:

determine two or more parameters associated with performance of the antenna;

when the two or more parameters meets a given criteria then smoothly change a brightness of the display by controlling the backlight as a function of the two or more parameters, the function comprising B=F(P1, P2, P3 . . . Pn), where B is the brightness of the display, where each of P1, P2, P3 . . . Pn is a different one of the two or more parameters, and F is one or more of a smoothly changing function, a linear function, and an exponential function, the brightness of the display smoothly increasing when one or more of the two or more parameter increases and the brightness of the display smoothly decreasing when one or more of the two or more parameter decreases, such that change in the brightness of the display varies smoothly according to the two or more parameters; and

monitor the two or more parameters and smoothly change the brightness of the display in a feedback loop with the two or more parameters.

2. The device of claim **1**, wherein the two or more parameters comprise one or more of a SAR parameter, an impedance parameter, a voice quality parameter, a VSWR parameter, a FER parameter, an EVM parameter, a BER parameter, a bandwidth parameter, and a QoS parameter, and the given criteria respectively comprises one or more of a threshold SAR level, one or more of a threshold impedance level and a given range of acceptable impedance levels, one or more voice quality threshold levels, one or more VSWR thresholds, one or more FER thresholds, one or more EVM thresholds, one or more BER thresholds, one or more bandwidth thresholds, and one or more QoS thresholds.

3. The device of claim **1**, wherein the two or more parameters comprise a reception of the antenna, and the given criteria comprises the reception being out of a given range thereby indicating poor reception at the antenna.

4. The device of claim **1**, wherein the two or more parameters comprise an impedance of the antenna, and the given criteria comprises the impedance being out of a given range thereby indicating impedance mismatch between the antenna and associated radio equipment.

5. The device of claim **1**, wherein the two or more parameters comprises voice quality provided at a speaker, and the given criteria comprises the voice quality being below a given voice quality threshold level.

6. The device of claim **1**, wherein the processor is further configured to change the brightness of the display in a pattern.

7. A method comprising:

at a device comprising at least one processor interconnected with an antenna, and a display, the display comprising a backlight, the backlight controlled by the at least one processor to control a brightness of the display, determining, at the processor, two or more parameters associated with performance of the antenna;

when the two or more parameters meets a given criteria then smoothly changing a brightness of the display by the at least one processor controlling the backlight as a function of the two or more parameters, the function comprising B=F(P1, P2, P3 . . . Pn), where B is the brightness of the display, where each of P1, P2, P3 . . . Pn is a different one of the two or more parameters, and F is one or more of a smoothly changing function, a linear function, and an exponential function, the brightness of the display smoothly increasing when one or more of the two or more parameter increases and the brightness of the display smoothly decreasing when one or more of the two or more parameter decreases, such that change in the brightness of the display varies smoothly according to the two or more parameters; and

monitoring the two or more parameters and smoothly changing the brightness of the display in a feedback loop with the two or more parameters.

8. The method of claim **7**, wherein the two or more parameters comprise one or more of a SAR parameter, an impedance parameter, a voice quality parameter, a VSWR parameter, a FER parameter, an EVM parameter, a BER parameter, a bandwidth parameter, and a QoS parameter, and the given criteria respectively comprises one or more of a threshold SAR level, one or more of a threshold impedance level and a given range of acceptable impedance levels, one or more voice quality threshold levels, one or more VSWR thresholds, one or more FER thresholds, one or more EVM thresholds, one or more BER thresholds, one or more bandwidth thresholds, and one or more QoS thresholds.

9. The method of claim **7**, wherein the two or more parameters comprise a reception of the antenna, and the given criteria comprises the reception being out of a given range thereby indicating poor reception at the antenna.

10. The method of claim **7**, wherein the two or more parameters comprise an impedance of the antenna, and the given criteria comprises the impedance being out of a given range thereby indicating impedance mismatch between the antenna and associated radio equipment.

11. The method of claim **7**, wherein the two or more parameters comprise voice quality provided at a speaker, and the given criteria comprises the voice quality being below a given voice quality threshold level.

12. The method of claim **7**, further comprising changing the brightness of the display in a pattern.

13. A non-transitory computer-readable medium storing a computer program, wherein execution of the computer program is for:

at a device comprising at least one processor interconnected with an antenna, and a display, the display comprising a backlight, the backlight controlled by the at least one processor to control a brightness of the display, determining, at the processor, two or more parameters associated with performance of the antenna;

when the two or more parameters meets a given criteria then smoothly changing a brightness of the display by the at least one processor controlling the backlight as a function of the two or more parameters, the function comprising B=F(P1, P2, P3 . . . Pn), where B is the brightness of the display, where each of P1, P2, P3 . . . Pn is a different one of the two or more parameters, and F is one or more of a smoothly changing function, a linear function, and an exponential function, the brightness of the display smoothly increasing when one or more of the two or more parameter increases and the brightness of the display smoothly decreasing when one or more of the two or more parameter decreases, such that change in the brightness of the display varies smoothly according to the two or more parameters; and

monitoring the two or more parameters and smoothly changing the brightness of the display in a feedback loop with the two or more parameters.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 9,170,289 B2
APPLICATION NO. : 13/541704
DATED : October 27, 2015
INVENTOR(S) : Mahinthan Veluppillai and Nagula Tharma Sangary

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In the Claims

Column 11 Claim 1, Line 6, the word “meets” should be replaced with “meet”.

Column 11 Claim 1, Line 16, the word “parameter” should be replaced with “parameters”.

Column 11 Claim 1, Line 18, the word “parameter” should be replaced with “parameters”.

Column 11 Claim 4, Line 41, it should read “comprises” not “a comprise”.

Signed and Sealed this
Thirtieth Day of January, 2018

Joseph Matal

Joseph Matal
Performing the Functions and Duties of the
Under Secretary of Commerce for Intellectual Property and
Director of the United States Patent and Trademark Office